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BY THE COMPTROLLER GENERAL

Report To The Chairman Committee On Energy And Commerce House Of Representatives

OF THE UNITED STATES

Producing More Fuel-Efficient Automobiles: A Costly Proposition

COMPLETED

40

Legislation establishing Federal fuel economy standards for automobiles required the auto industry to produce new-car fleets that averaged 18 miles per gallon starting with model year 1978, increasing to 27.5 miles per gallon by 1985. Industry expects to spend about $70 billion (in constant 1980 dollars) on buildings, property, equipment, and retooling over the next several years to produce new, small, fuel-efficient autos that will compete with foreign imports. Comparable expenditures for the pre-fuel economy period of 1970-74 were $35 billion, and in the initial fuel economy period of 1975-79, they were $41 billion. The industry expects that it will attain fleet averages of about 31 miles per gallon by 1985.

Market demand for more fuel-efficient cars coupled with foreign competition will probably lead the auto industry to keep on producing fuel-efficient automobiles for the future. Although existing technologies can approach a fleet average of 40 miles per gallon and beyond, the major uncertainty concerning the production of such automobiles appears to be the risk of financing the large capital investments needed.

CED-82-14
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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-203958

The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

Dear Mr. Chairman:

At your request, we reviewed factors relating to fuel economy standards for automobiles administered by the Department of Transportation. This report discusses the progress and problems of the automobile industry in meeting the present fuel economy standards and provides information that may be helpful if the Congress considers establishing future fuel standards for the post-1985 period.

As the committee requested, we did not obtain official comments from the Federal agencies discussed in the report. We did, however, discuss our findings with agency and industry officials at the conclusion of our field work, and their views have been incorporated in appropriate sections of the report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

III

COMPTROLLER GENERAL'S
REPORT TO THE CHAIRMAN
COMMITTEE ON ENERGY
AND COMMERCE
HOUSE OF REPRESENTATIVES

PRODUCING MORE FUEL-EFFICIENT AUTOMOBILES: A COSTLY PROPOSITION

D I G E S T

In 1975 the Congress established the Federal fleet average fuel economy standards for automobiles. Beginning with model year 1978, manufacturers' new-car fleets were required to attain 18 miles per gallon (mpg), increasing to 27.5 mpg by 1985 and thereafter. (See p. 1.)

The domestic automobile industry expects to spend over $70 billion (in constant 1980 dollars) through 1984 on buildings, property, equipment, and retooling to produce new, small, fuel-efficient autos that will compete with foreign imports. Comparable expeditures for the pre-fuel economy period of 1970-74 were $35 billion and in the initial fuel economy period of 1975-79, were $41 billion. The industry expects that it will attain fleet averages of about 31 mpg by 1985. (See p. 17.)

Sagging revenues due to conditions such as high interest rates and foreign competition have cost the automobile industry over $4 billion in losses in 1980. Although technology is available to achieve higher levels of fuel efficiency--approaching 40 mpg and beyond--a major uncertainty is the risk of financing the large capital investments needed to achieve improved fuel economy of automobiles.

This report was prepared in response to a request from the House Committee on Energy and Commerce, which asked GAO to (1) examine the background for the current fuel economy standards, (2) review pertinent studies that assess the potential for attaining further fuel economy improvements, and (3) obtain information on the financial impact of the fuel economy standards on the automobile industry in meeting such standards. (See p. 4.)

WHY THE FUEL ECONOMY STANDARDS WERE DEVELOPED

The Federal fuel economy standards were established in response to fuel shortages and concern that the Nation's dependence on foreign oil posed a threat to national security and the economy. A major goal of the standards was to reduce U.S. gasoline consumption through the production and sale of more fuel-efficient automobiles. (See p. 1.)

The automobile accounts for about 30 percent of all petroleum consumption and is a major factor contributing to the Nation's dependence on foreign oil. (See p. 1.)

IMPACT OF TRANSITION TO SMALL CARS ON AUTO INDUSTRY

After the fuel economy standards were established, the automobile industry expressed concern about having to produce cars that met the fuel standards within the specified time frames. Industry felt that it did not have enough time to redesign its equipment and plants to produce automobiles that met the fuel standards. (See p. 9.)

During the 1970's, real gasoline prices rose substantially--the 1972 average price of a gallon of gasoline was 70 cents in constant 1980 dollars and $1.23 in 1980, an increase of 76 percent. The average pump price was 35 cents per gallon in 1972 and $1.23 in 1980--a 250-percent increase. (See p. 12.)

By 1979 Americans were purchasing imported, smaller, more fuel-efficient automobiles in record quantities as a result of gasoline shortages and increasing prices. Americans chose imported small cars because domestic automobile manufacturers were not producing enough smaller, fuel-efficient cars and because the imports were perceived as being of better quality than the American automobiles. (See p. 14.)

To compete with the imports and produce automobiles that meet the fuel economy standards, the Nation's automotive industry began pouring huge amounts of capital into redesigning its product line. The industry produced automobiles that met the initial fuel standards through 1981; it expects its products to exceed the 1985 Federal fuel economy standard of 27.5 mpg by about 3 mpg. However, the $70 billion capital investment scheduled through 1984 and sagging revenues due to high car prices and high interest rates have placed the auto industry in a weakened financial position for the next several years. (See pp. 16 to 18.)

GAO's cash-flow analysis of the two major auto producers, based on projections, showed that they will most likely have negative cash flows of between $3.6 and $4.7 billion in 1981 and

$1.6 and $2.7 billion in 1982. The financial positions of these companies might improve in 1983 and 1984, but that depends heavily upon increased sales. (See p. 19.)

Several studies of potential fuel economy gains beyond 1985 present two scenarios:

--A moderate improvement (35 to 40 mpg) by the early to mid-1990's.

--A rapid improvement (over 40 mpg) by the 1990's.

The studies concluded that fuel economy gains will come primarily from more widespread use of the present technology--weight reduction, material substitution, smaller engines, and improved fuel systems. Generally, the studies concluded that technology was available to achieve higher fuel economy in new vehicle fleets but questioned whether the industry could afford to make the high capital investments necessary to achieve fuel economy without financial risk. Estimates of the amount needed ranged from $10 billion to $150 billion, depending on how fast improvements are made and the mpg level sought. (See pp. 23 to 26.)

CONCLUSIONS

The market demand for more fuel-efficient cars coupled with the competition from foreign imports will most likely motivate the domestic auto industry to develop more fuel-efficient automobiles for the future.

Although technologies are available to produce new-car fleets that approach or exceed a 40-mpg average, a major uncertainty is the risk of financing the large capital investments needed to produce such automobiles. (See p. 29.)

AGENCY COMMENTS

As requested by the House Committee on Energy and Commerce, GAO did not request official comments from the Federal agencies discussed in this report.

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ABBREVIATIONS

CBO	Congressional Budget Office
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
GAO	General Accounting Office

CHAPTER 1

INTRODUCTION

This report, requested by the House Committee on Energy and Commerce, discusses the transition that the auto industry is undergoing and the efforts being made to achieve greater fuel economy.

During the 1970's important changes took place in petroleum supplies and prices, both domestically and internationally. Previously there was an abundant supply of petroleum at reasonable prices for the domestic market. The Nation faced uncertain supplies of imported oil beginning with the oil embargo of 1973-74. Energy experts predict supply shortages and increased prices of petroleum through the end of the century. The oil embargo signaled a change in the Nation's ability to control its own economic security and well-being.

In response to the shortages of petroleum and concern that the Nation's dependence on foreign oil posed a threat to the national security and economy, the Congress enacted the Energy Policy and Conservation Act of 1975 (15 U.S.C. 2002), a comprehensive energy program designed to promote domestic energy production and restrain energy usage. The act authorized the establishment and enforcement of fleet average fuel economy standards for automobiles and light trucks. These standards are discussed in chapter 2 of this report.

THE AUTOMOBILE'S USE OF PETROLEUM

The automobile accounts for about 30 percent of the Nation's petroleum consumption as of 1978 and is a major factor in the Nation's dependence on foreign oil. Petroleum demands escalated throughout the 1960's and most of the 1970's, leading to greater dependence on foreign oil. In 1960 the United States consumed 3.59 billion barrels of petroleum and imported about 20 percent of that amount. Petroleum consumption peaked at 6.88 billion barrels in 1978. Consumption declined to 6.17 billion barrels in 1980, about 37 percent of which was foreign oil. The cost of foreign oil was about $80 billion in 1980.

As shown in figure 1, the transportation sector consumed about 53 percent of all the petroleum used domestically in 1978. Figure 2 shows that the automobile accounted for nearly 75 percent of all gasoline consumed by highway vehicles.

FIGURE 1

U.S. PETROLEUM CONSUMPTION BY SECTOR (1978)

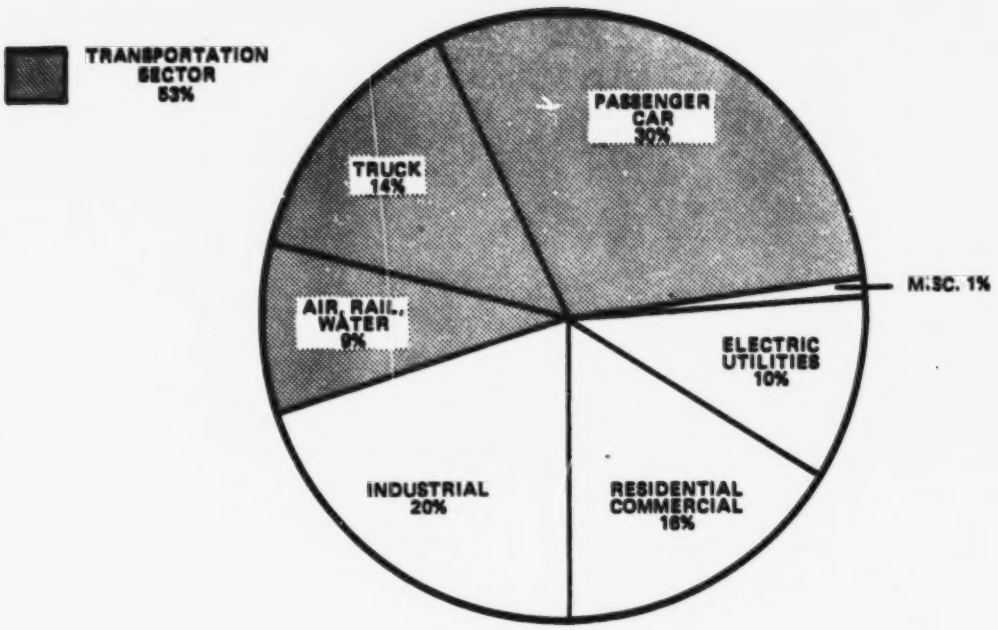
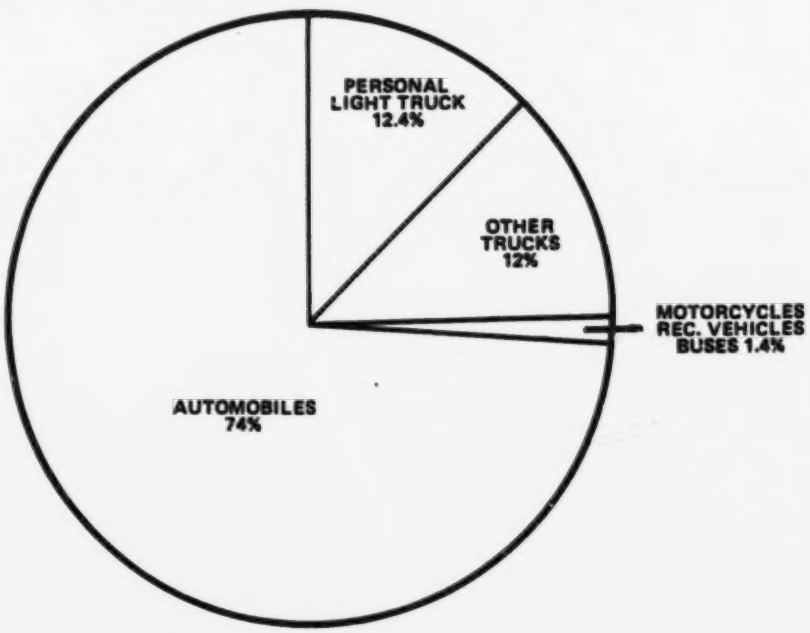


FIGURE 2

HIGHWAY GASOLINE CONSUMPTION BY VEHICLE TYPE (1978)



One means of reducing automobile fuel consumption has been to improve the average fuel efficiency of new cars. The Department of Transportation (DOT) estimated that achieving the fuel economy standards for automobiles will save 357.6 million barrels of oil annually by 1985. This represents about 16 percent of the total amount of petroleum imported in 1980. Also, DOT estimated that as more of the fuel-efficient vehicles replace older, less fuel-efficient vehicles on the highways, cumulative oil savings from cars and light trucks meeting these standards will amount to 15.7 billion barrels from 1978 to the year 2000--nearly seven times the petroleum imported in 1980. Because automakers expect to exceed the fuel economy standards, DOT estimated an additional cumulative savings of 8.5 billion barrels of oil.

DOMESTIC AUTO INDUSTRY

The domestic auto industry is an important part of the Nation's transportation system and economy. Auto travel accounts for about 83 percent of all intercity passenger-miles and about 95 percent of all travel within cities. Activities associated with automobile and truck production and services make up 8.5 percent of the gross national product and more than 25 percent of all retail sales in the Nation.

In addition, the auto industry directly or indirectly employs about 20 percent of the total domestic work force. Auto production uses 60 percent of the Nation's synthetic rubber, 30 percent of its ferrous castings, 21 percent of its steel production, and 20 percent of its machine tools. Because of its scale and reach, the auto industry has played a central role in accomplishing some of the Nation's broadest goals, such as work for Americans and national security, according to a DOT report entitled "The U.S. Automobile Industry 1980" dated January 1981.

The following table presents dollar sales, net losses, and total assets for the five major auto producers in the United States:

Manufacturer	Calendar year 1980 Sales	Net income (loss)	Assets
	(millions)		
General Motors Corporation	$57,729	$ -763	$34,581
Ford Motor Company	37,086	-1,543	24,348
Chrysler Corporation	9,225	-1,710	6,618
American Motors Corporation	2,553	-198	1,029
Volkswagen of America, Inc.	3,191	Not available	105

The domestic auto producers have overseas operations and ties with foreign automobile companies. For instance, both the General Motors Corporation and the Ford Motor Company have Canadian and overseas plants and foreign sales operations. The financial data from these operations is included in the above table. In 1980 the French automaker Regie Nationale des Usines Renault became a 46-percent partner in the American Motors Corporation. Volkswagen of America, Inc., is a subsidiary of the West German firm, Volkswagenwerk AG, which assembled its Rabbit models with less than 75 percent domestic materials in 1980. The Chrysler Corporation divested itself of most of its overseas operations at the end of 1979 but has continued certain Canadian operations and has an agreement to sell vehicles produced in Japan by Mitsubishi, Inc.

OBJECTIVES, SCOPE, AND METHODOLOGY

We conducted this review in response to a request from the House Committee on Energy and Commerce. Our objectives were to:

--Examine the background for the current fuel economy standards for vehicles.

--Review various studies that project future technological potential for attaining further fuel economy improvements for vehicles.

--Obtain information on the financial impact on the auto industry of producing fuel-efficient automobiles.

We discussed the fuel economy standards with officials of the National Highway Traffic Safety Administration (NHTSA) and DOT; Environmental Protection Agency (EPA); and the Department of Energy (DOE) headquarters in Washington, D.C.

We discussed the technology and economics of further fuel economy improvements with DOT's Transportation Systems Center (TSC) staff in Cambridge, Massachusetts. TSC performs technological and socioeconomic research involving the transportation sector for DOT. The TSC staff has a broad range of analytical skills, including engineering, scientific, socioeconomic, and other skills.

Our review was directed to the fuel economy standards for automobiles because autos use the bulk of petroleum consumed in the transportation sector. We did not examine fuel economy standards for light trucks. We visited representatives of the two largest automobile manufacturers, the General Motors Corporation and the Ford Motor Company. We discussed product plans and capital investment schedules through 1985. These two companies were selected for analysis because their combined sales account for about 80 percent of the domestically produced cars sold in the United States in 1980.

To obtain some measure of the financial impact on the auto industry of switching to production of fuel-efficient automobiles, we asked TSC for help in projecting cash-flow data for General Motors and Ford. TSC developed the cash-flow projections by using a mathematical matrix. We did not verify all the operating and financial data furnished to us by TSC and used in our cash-flow projections of the automotive companies. But we did verify certain historical financial data with audited annual reports of the automotive companies. In addition, we spoke with the first vice president, Paine, Webber, Mitchell, Hutchins--a leading brokerage firm that specializes in analyzing the automobile industry for investment purposes--to obtain the firm's assessment of General Motors' and Ford's cash-flow situation.

We contracted with Chase Manhattan Bank's Automotive Division of Philadelphia, Pennsylvania, to provide us with domestic car and truck sales forecasts used in the cash-flow projections. We did not verify the accuracy of these sales forecasts. The Chase Automotive Division is a leading private forecasting service for the automotive industry, and its staff is a multidisciplinary team of experts with extensive background in energy, economics, engineering, consumer psychology, market research, statistics, operations research, and data base management. The Chase Automotive Division's car market model is designed to simulate demand for new passenger cars within an econometric framework at the total industry level and by market class--size of car determined by wheelbase. Its model incorporates the effect of an array of demographic and energy factors; automobile characteristics; and economic variables relating to income, prices, cyclical variations, government regulations, and changes in consumption patterns.

The cash-flow projections were developed for two sets of sales forecasts--scenario A, representing the most likely sales

forecast, and scenario B, representing a lower, or pessimistic, sales forecast. The cash-flow projections are discussed in chapter 3. The cash-flow analysis assumed that total sources of funds were derived for 1981 and 1982 based on the following factors:

1. Domestic factory sales were obtained by allocating the gross domestic sales forecasts to the various domestic producers on the basis of their planned production capacities for the various car and truck segments--for example, subcompact, compact, intermediate--and by applying estimated weighted vehicle factory dealer prices.

2. Foreign factory sales were based on projected trend sales and factory sales price estimates contained in TSC's matrix.

3. Net income was determined by subtracting variable and fixed-cost estimates from the gross sales figures and applying Federal, State, and local tax estimates.

4. Total sources of cash were derived by adding back into net income the estimated amortization and depreciation writeoffs (noncash expenses charged to income). TSC calculated the amortization and depreciation expense estimates on the basis of historical capital investment trends and projected investment trends for calendar years 1981 and 1982.

Application of funds or cash needs were based on the following factors:

1. Dividends paid out were estimated on the basis of historical payouts and potential reductions based on cash-flow problems.

2. Capital expenditures were based on the domestic producers' publicly announced capital investment plans.

During our review work, we did not try to perform technical analyses of the existing technology for achieving more fuel-efficient automobiles in the future or to estimate the costs and benefits of technological improvements. Instead, we relied on discussions with technical experts inside Government and industry to make our judgments on the usefulness of the techniques and methodologies being used to assess the auto industry. Also, we used several studies which assessed the potential for achieving more fuel-efficient automobiles in the future. (Representatives of the Office of Technology Assessment and Congressional Budget Office indicated to us that these were the pertinent studies available which assessed fuel-efficient automobiles.) We did not assess the various methodologies used in the studies.

During the coordination phase of our work, the Office of Technology Assessment's liaison mentioned the report by the Energy Production Center of the Mellon Institute entitled "Maintaining Automotive Mobility: Using Fuel Economy and Synthetic Fuels to Compete with OPEC Oil," dated August 1980, and the Congressional Budget Office's liaison mentioned the Congressional Budget Office report entitled "Fuel Economy Standards for New Passenger Cars After 1985." GAO staff working on the Chrysler Corporation's Loan Guarantee Program in the Program Analysis Division mentioned the DOT reports on (1) "Long-Term Viability of the Chrysler Corporation's Involvement in the Automotive Industry," dated January 1981, and (2) "The U.S. Automobile Industry, 1980," dated January 1981.

Estimates of future fuel consumption were derived from mathematical models. Because of uncertainties about future economic conditions, three separate projections were made using various assumptions to compute annual mileage driven figures.

1. Total annual mileage will grow at a compounded 3.5-percent annual rate, the approximate rate that it has grown in the past. We consider this as a pessimistic case, or a poor prospect for fuel savings.

2. Annual mileage will remain fixed at the 1978 level of 1,190 billion miles. We consider this as the optimistic case for consumption since there is a good prospect for fuel savings.

3. Annual mileage will depend on a number of factors; such as, the number of households, per capita disposable income, gasoline prices, passenger car fuel efficiency, and disruption in gasoline supplies. We refer to this as the base case. The results in this case closely parallel those in the optimistic case.

To obtain estimates of annual mileage in our base case, we used historical data on the factors listed above and employed a statistical procedure called regression analysis to produce a formula for projecting annual mileage. To make these projections it was necessary to obtain estimated values for the factors in the formula. Some of these values were obtained from Data Resources, Inc., a well-known econometric modeling firm. For example, Data Resources projects in its base case that oil prices will most likely increase by an average of 11.5 percent per year, resulting in a price of $8.60 per gallon in the year 2000, and that per capita income will be $47,000 compared with $9,000 in 1981. Data Resources also assumes no future oil embargoes.

After making these projections of the annual mileage, we computed total fuel consumption by dividing the miles driven by the fuel efficiency--miles per gallon (mpg) of each model of the passenger car fleet in each of the above years. In making these

estimates, two factors are critical. The first is the ultimate mpg efficiency that is achievable for new passenger cars. We used four different figures as the ultimate mpg achievable--30, 40, 50, and 60 mpg. The second factor is the rate at which new cars are purchased and old cars retired. We assumed constant turnover of annual new car sales and retirement by age of model year. Thus the increase in mpg was assumed to be achievable in a gradual, or straight line, manner. For example, if the 1985 new cars were averaging 30 mpg and one wanted ultimately to achieve 50 mpg, we assumed a 40-mpg figure would be achieved in 1990 and a 50-mpg figure in 1995.

As requested by the House Committee on Energy and Commerce, we did not request official comments from the Federal agencies discussed in this report. We did verify the factual information with officials of the General Motors Corporation and the Ford Motor Company and agencies included in our review.

CHAPTER 2

FEDERAL FUEL STANDARDS FOR AUTOMOBILES

The 1973-74 Arab oil embargo demonstrated the consequences to the Nation's economy of depending on large quantities of imported petroleum. The oil embargo caused shortages of fuel, long gas lines, and higher fuel prices for many Americans. The shortages and higher prices of fuels sparked debate in the Congress on the need for automobile fuel economy standards. Because of concern that growing dependence on imported petroleum posed a threat to the national security and economy, the Congress established fuel economy standards that new cars were required to meet beginning in 1978.

The standards require automobile manufacturers to produce a fleet of cars that, overall, meet certain minimum mileage standards, as shown below.

Model year	Average fuel economy standard (in miles per gallon)
1978	18.0
1979	19.0
1980	20.0
1981	a/22.0
1982	a/24.0
1983	a/26.0
1984	a/27.0
1985 and thereafter	27.5

a/Determined by Secretary of Transportation and published in 42 Fed. Reg. 33534 (June 30, 1977).

In addition, the Energy Policy and Conservation Act established goals for 1980- and 1985-model year cars that would improve mpg levels by nearly 50 percent and 100 percent, respectively, over the 1974 estimated average mpg for automobiles of 14 mpg. Manufacturers were required by the act to raise the average mpg of the vehicles they produced to the prescribed levels or pay a penalty for every car produced.

MANUFACTURERS QUESTION FUEL ECONOMY STANDARDS AND TEST PROCEDURES

Although domestic manufacturers agreed to the standards established by the Congress, they questioned (1) the interim, federally mandated fuel economy standards that covered the 1981-84 period and (2) certain changes to the test procedures that the Federal Government used to determine whether vehicles met the fuel economy standards.

In 1978 General Motors Corporation and Ford Motor Company sought lower fuel economy standards for model years 1981-84. The manufacturers contended that in the short run--the late 1970's--they would use the most cost-effective methods for improving fuel economy that did not require extensive lead time to develop. The technologies needed to comply with standards for the mid-1980's will be the more costly remaining methods and will take more lead time to develop. Also, they indicated that a reduction in the standards through model year 1984 would give them more time to develop new technology to meet the later standards and that the new technology would be more desirable to consumers.

The auto manufacturers suggested that less stringent standards for the 1981-84 period would permit a reduction in the capital investment and in new-car prices. They argued that a schedule of fuel standards that increased by 1.5 mpg annually from 1980 to 1984 would provide a net economic saving to new-car purchasers, compared with the 2-mpg increase in the current fuel economy standards for 1981, 1982, and 1983. This issue seems to have evaporated when consumer preference switched to small, fuel-efficient cars near the end of 1979. At that time the domestic auto industry began to go all-out to meet the demand for fuel-efficient cars.

Since 1976, EPA has developed fuel economy test procedures and regulations for the Federal Government's mandatory fuel-economy labeling program and began testing automobiles for the labeling program. (Additional details on the EPA labeling program are contained in our report to the Chairman, House Committee on Energy and Commerce, entitled "Consumers Need More Reliable Automobile Fuel Economy Data," dated July 28, 1981 (CED-81-133).)

Beginning in January 1979, the auto manufacturers started complaining to EPA that certain changes to the test procedures yielded inaccurate information for calculating the corporate average fuel economy data. The manufacturers argued that the changes had cost them an average of 0.6 mpg in calculating their corporate average fuel economy data--used to assess penalty payments. Therefore, the manufacturers felt they were exposed to potential penalties for not meeting the fuel economy standards. They felt that EPA should add a correction factor to offset the shortfall of about 0.6 mpg.

The most significant change EPA made to the fuel economy test procedures involved the weight levels for test cars. From 1975 to 1979 EPA had simulated the weight of its test vehicles in increments of 250 pounds (for vehicles weighing 3,000 pounds or less) and 500 pounds (for vehicles weighing 3,000 to 5,500 pounds). Beginning with the 1980 model year, EPA halved the weight increments to 125 and 250 pounds to prevent manufacturers from manipulating weight classes to their advantage. For example, if a test vehicle's weight was set at 4,749 pounds, under

the earlier procedures the vehicle would have been tested at 4,500 pounds--the closest 500-pound increment. This would be a clear advantage because a difference of 100 pounds can mean a 1- to 3-percent change in fuel economy. Under the 1980 change, the vehicle would be tested at 4,750 pounds--the closest 250-pound increment. This change results in a decrease in the fuel economy rating in those cases where a vehicle would otherwise have been tested at a lower weight increment.

In July 1979 General Motors and Ford petitioned EPA on the fuel-testing procedure changes, arguing that they had caused their measured fuel economy averages to be 0.6 mpg lower than the averages potentially attainable under the earlier test procedures. The EPA Administrator denied those petitions, and the case is being reviewed by the United States Court of Appeals for the Sixth Circuit as of September 1981.

CONCLUSIONS

The 1973-74 Arab oil embargo demonstrated the consequences to the Nation's economy of depending on large quantities of imported petroleum. The oil embargo caused shortages of fuel, long gas lines, and higher fuel prices for many Americans. To deal with the petroleum problem, the Congress enacted legislation aimed at reducing the Nation's dependence on imported petroleum by establishing fuel economy standards for automobiles. The automobile manufacturers have met the Federal fuel economy standards and expect to produce automobiles which on an average fleet basis will exceed the 1985 27.5-mpg standard by about 3 mpg.

CHAPTER 3

PROGRESS AND PROBLEMS IN PRODUCING MORE FUEL-EFFICIENT AUTOMOBILES

To compete with the foreign imports and produce automobiles that meet Federal fuel economy standards, the Nation's automotive industry began spending massive amounts of capital to redesign its product line. The auto industry has produced automobiles that meet the fuel economy standards through 1981. Furthermore, the industry expects to be able to produce some 10 million newly designed automobiles by 1984 that will on average exceed the present 27.5-mpg fuel standards, approaching the 31-mpg level by 1985.

To produce higher mpg-rating cars, the auto industry expects to make capital investments of about $70 billion during the next few years. However, the industry is also facing record negative cash flows. Sagging revenues due to the high price of cars and high interest rates have put the industry in a weakened financial position.

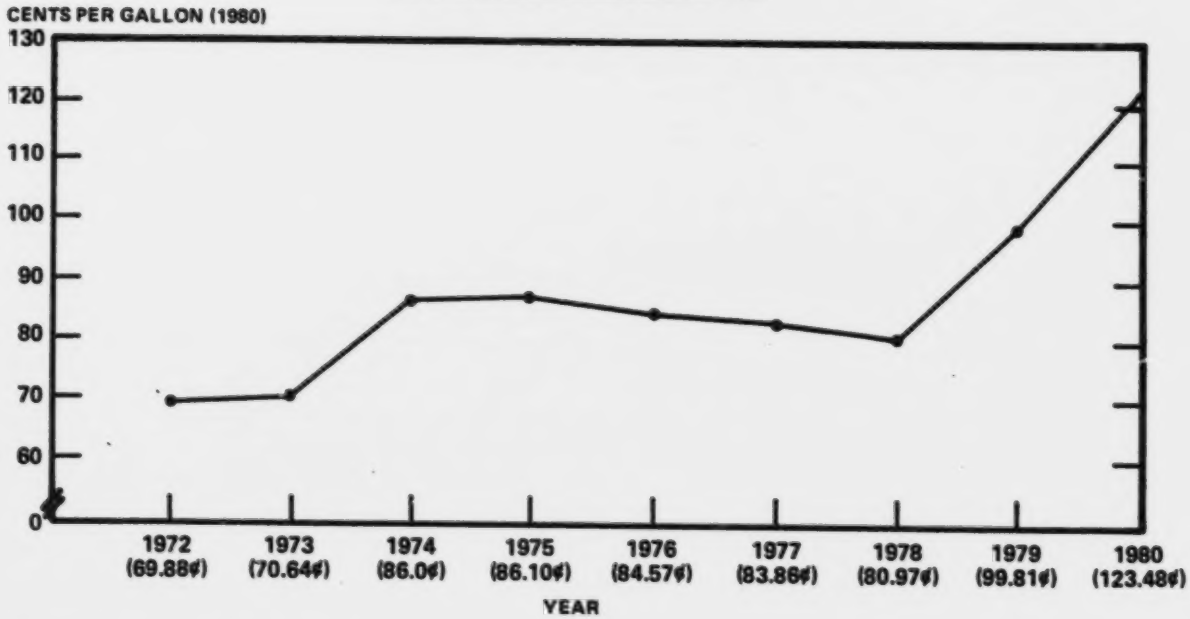
Several studies have been made of potential fuel savings beyond 1985. Generally the studies agree that while technology exists to improve fuel economy beyond 1985 levels, the large capital investments required to do so would put the auto industry at financial risk.

MARKET DEMAND INCREASED FOR MORE FUEL-EFFICIENT AUTOMOBILES

During the 1970's, gasoline prices rose substantially, as shown in figure 3.

FIGURE 3

ANNUAL AVERAGE U.S. RETAIL GASOLINE PRICES IN CONSTANT 1980 DOLLARS

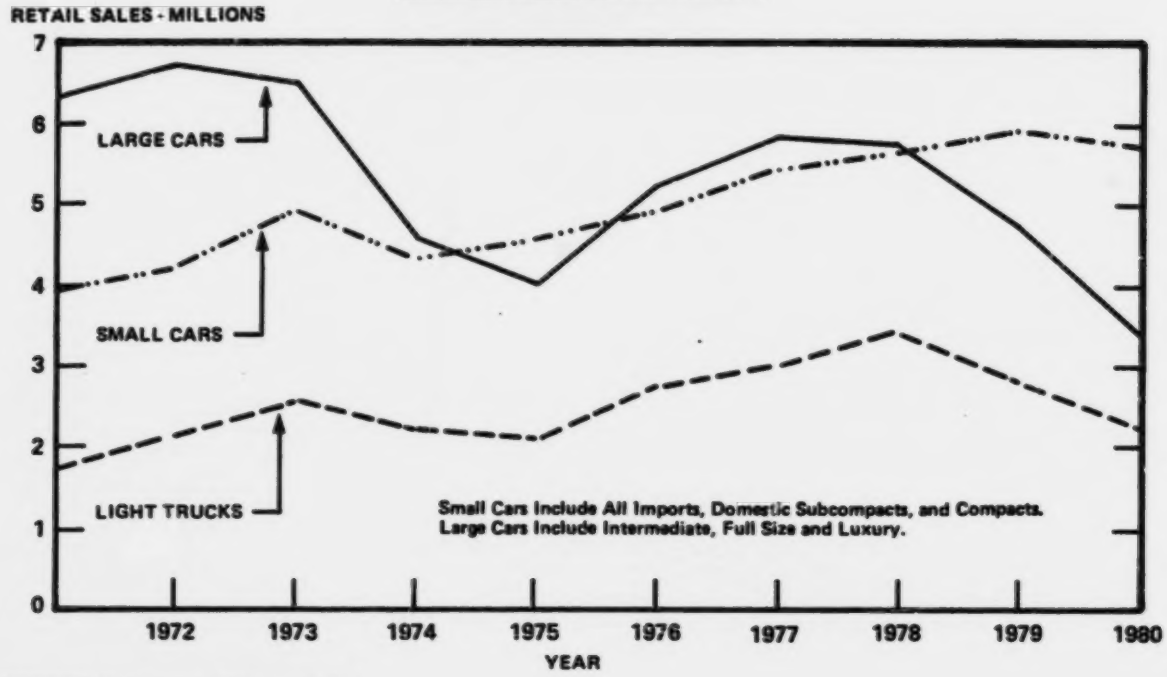


SOURCE: Department of Transportation

Although these figures accurately show the real increase in prices, it was the figure on the pump that the average consumer was concerned about. The average pump price of a gallon of gasoline was 35 cents in 1972 and $1.23 in 1980--a 250-percent increase.

FIGURE 4

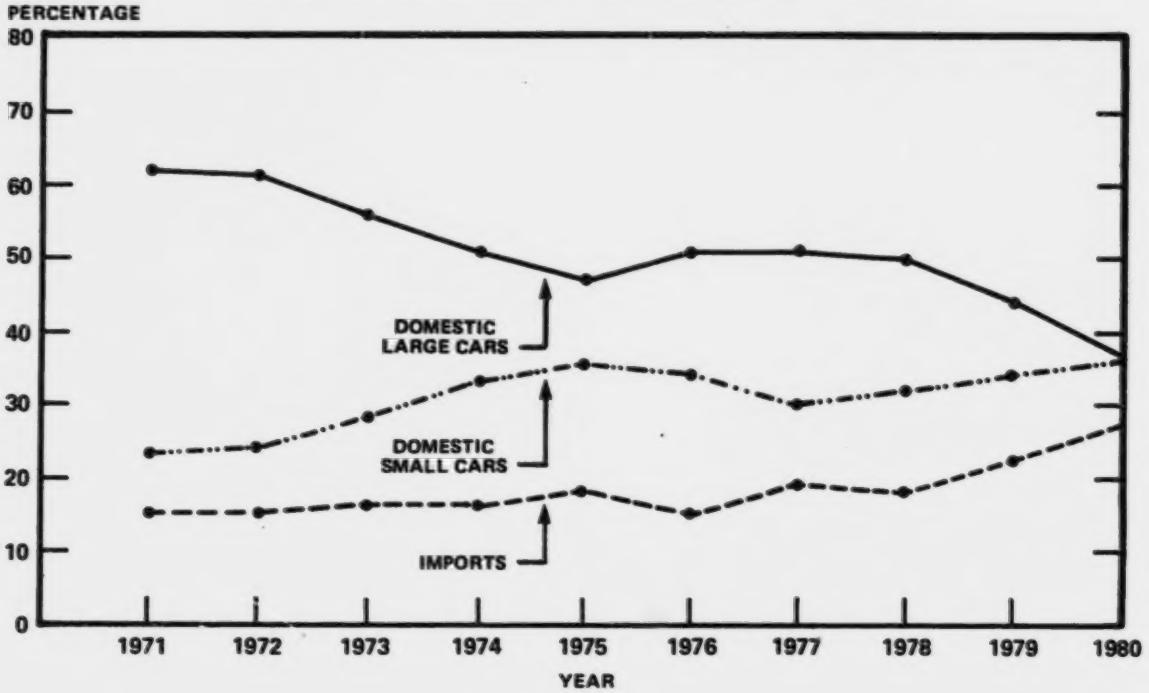
RETAIL SALES OF VEHICLES



SOURCE: Department of Transportation

FIGURE 5

PERCENTAGE OF NEW CAR SALES BY MARKET CLASS



The 1973-74 oil embargo marked the first major turning point in motor vehicle demand. Before that time, gasoline consumption in the United States was on a long-term growth trend, with large cars dominating domestic vehicle sales. As a result of the embargo and the resulting rapid increase in gasoline prices, large-car demand shifted from 61 percent of the market in 1972 to 47 percent in 1975, and demand for domestic small cars shifted upward from 23 percent to 35 percent, respectively. By 1980, domestic large cars and small cars each represented about 37 percent of the new-car market sales. Figures 4 and 5 show the retail sales of vehicles and percentage of new-car sales by market class.

Industry had some difficulty gearing production to consumers' shifting demands

The increased demand for small cars had serious implications for the domestic automakers. The Secretary of Transportation concluded in a report to the Congress entitled "Long Term Viability of the Chrysler Corporation's Involvement in the Automotive Industry," dated January 1981, that:

> "* * * [The 1973] demand shift left the domestic auto makers in a difficult situation, as they had just completed a model year introduction which was based on a different mix. The output of small cars had been increased in the Fall of 1973, but not nearly enough to anticipate the sudden shock of the mix shift. In response to this shift, the auto makers performed a rapid second model year changeover during the winter months. Larger car plants were shut down in the middle of the model year and converted to produce a greater proportion of smaller cars."

By mid-1974, however, fuel prices somewhat stabilized and buyers returned to purchasing larger, less fuel-efficient vehicles. With demand now geared toward not only the larger cars but also light trucks, the industry found itself with large inventories of small cars and was forced to initiate rebate and discount programs aimed at clearing up the backlogs.

In 1979, as a result of disruptions in the Iranian oil exports and the increase in gasoline prices, the auto consumer changed once again in favor of more fuel-efficient cars. A report by the Subcommittee on Trade, House Committee on Ways and Means, entitled "Auto Situations: 1980," dated June 6, 1980, indicated that another reason that Americans selected imported autos was the quality issue, both perceived and real. The implications of this sudden shift were pointed out by DOT's report entitled "Long Term Viability of the Chrysler Corporation":

"These conditions prompted an even more radical shift in vehicle mix demand than that produced in 1973, and the carmakers' trend line projection of product changes was totally outdated within several months. The light truck market, previously so strong, dropped from an annualized rate of about 2.5 million vehicles in late 1978 to about 1.6 million vehicles in mid-1979. Import inventory surpluses were cleaned out within three months, and long lines of orders piled up at dealers."

* * * * *

"Price conditions on small and large cars reversed dramatically, with many consumers suddenly willing to pay price premiums on the most desired small cars. Margins on larger cars dropped precipitously as the makers had to discount heavily to clean inventories built up during the spring of 1979."

The demand for fuel economy has continued as evidenced by the small-car share of the domestic market. Total small-car sales rose from 56 percent of the total domestic market in 1979 to 63 percent in 1980.

The trend toward increased small-car purchases is likely to continue if the real price of gasoline continues to rise. Many energy experts have projected that gasoline costs will increase in the future. The market share of small cars could rise to 71 percent by 1995 due to future increases in gasoline prices according to a report by the Congressional Budget Office entitled "Fuel Economy Standards for New Passenger Cars After 1985."

Imports of foreign automobiles increased

When Americans demanded smaller, more fuel-efficient cars in the 1970's, Japanese auto manufacturers were ready to fill part of that need because they had been producing that type of car for many years. The market share of Japanese imports increased, while the domestic large-car share dropped. In 1980 about 8.9 million automobiles were sold in the United States. Of this amount, about 6.6 million were domestic cars and 2.3 million were imported. The Japanese supplied 1.9 million, or 82 percent, of all imported cars.

Because the domestic auto industry was plagued with high unemployment and plant closings, political pressure began to mount for restrictions on imported automobiles. In addition, the United States Trade Representative (the office responsible for setting and administering overall trade policy and headed by an official who is directly responsible to the President) met with the Japanese Government to seek lower auto exports to the United States. In May 1981, the Japanese Government

announced that it was taking temporary measures to limit its auto exports to the United States to 1.68 million units for the 1981 model year. Also, it agreed to monitor the market during 1982 and 1983 and make similar adjustments if necessary. Some domestic auto manufacturers felt that this action was a positive step to assist their troubled industry; however, union representatives felt that more restrictive limits should have been imposed.

FINANCIAL IMPACT OF TRANSITION TO PRODUCING FUEL-EFFICIENT AUTOMOBILES

To compete with foreign auto manufacturers and produce automobiles that meet the fuel economy standards, U.S. auto manufacturers will have to make huge capital investments. The manufacturers must make these investments despite their record losses, estimated to total more than $4 billion in 1980. The extensive retooling of production facilities needed to build the new, smaller, fuel-efficient cars will cost domestic manufacturers unprecedented amounts of capital over the next few years.

General Motors Corporation, in its 1980 annual report, announced worldwide investment needs of $40 billion over the 1980-84 period, or an average of $8 billion annually. This compares with capital investments of $22 billion (constant 1980 dollars) during the period 1975-79 when initial efforts were begun to seek fuel-efficient automobiles and $10 billion (constant 1980 dollars) during the period 1970-74 before the fuel economy standards were in effect. Ford Motor Company's worldwide investment schedule for the same period assumes spending of about $19 billion. This compares with capital investments of $13 billion (constant 1980 dollars) during the period 1975-79 and $10.7 billion during the 1970-74 period.

DOT's report entitled "The U.S. Automobile Industry, 1980," dated January 1981, indicated that in order to overcome the comparative disadvantages and compete successfully in the new international market, the domestic automakers face some major capital expenditures to retool their production facilities. DOT estimated that the industry will spend some $70 billion over the next 5 years to produce the small, fuel-efficient automobiles in spite of record losses in excess of $4 billion for 1980. The proposed capital investments are substantially greater in comparison with the pre-fuel economy period of 1970-74, when the industry spent about $35 billion, and the initial fuel economy phase of 1975-79, when about $41 billion was spent. All the above figures are expressed in 1980 constant dollars. The DOT report concluded that these factors left the major auto manufacturers facing record negative cash flows.

According to the same DOT study, the auto industry expects to be able to produce some 10 million newly designed automobiles by 1984 that exceed the present 27.5-mpg fuel standards, approaching 31 mpg by 1985.

The following table compares capital spending by the General Motors Corporation and the Ford Motor Company for the period 1970-84.

Capital Spending for Property, Plant, Equipment, and Tooling

	1970-74	1975-79	1980-84
	(billions)		
General Motors Corporation:			
Actual	$10.425	$18.142	
Constant 1980 dollars	18.195	22.158	$40.0
Ford Motor Company:			
Actual	6.179	10.756	
Constant 1980 dollars	10.730	13.031	18.8

Depressed sales and revenues

While capital needs are escalating, the revenues needed to finance them have plummeted. In 1980 domestic automakers reported the worst losses in their history. General Motors reported a loss of $763 million and Ford reported a loss of $1.5 billion.

A number of factors are contributing to these depressed revenues. Domestic sales have been aggravated by (1) the shift in consumer demand from large to small cars, (2) increased imports (primarily Japanese), and (3) rising new-car prices and interest rates. In 1980 the average new-car selling price was $7,340 and the average interest rate for a 36-month loan was about 14.6 percent. As of October 1981, the sales price of many new full-size automobiles exceeded $10,000. This "sticker shock" has caused many people to put off buying a car unless they really need one.

Cash-flow problems

The combination of unprecedented capital investment requirements and record low sales and losses is resulting in negative cash-flow problems for the General Motors Corporation and the Ford Motor Company. Historically the auto industry has financed most of its capital investment requirements--new plant, equipment, and tooling--with internally generated cash flows--essentially net cash inflows from operations. Investment spending in excess of internally generated sources of funds from operations results in negative cash flow and if significant could force the companies to seek external funding--debt and/or equity. Even with extensive borrowing, the cash-flow pressures being exerted on these companies, especially Ford, will force them to cut costs through a combination of using foreign sources more and/or cutting or postponing new product plans.

To measure the impact on the auto industry of needing to invest capital at a time of depressed sales revenues, we performed a cash-flow analysis of the two major domestic companies, the General Motors Corporation and the Ford Motor Company. For the purpose of our analysis, "negative cash flow" is defined as the excess of disbursements over receipts (excluding the proceeds received from long-term financing). General Motors had a negative cash flow in 1979, before financing, of about $800 million; in 1980 the amount increased to about $5.2 billion. As a result of this cash drain, General Motors borrowed $1.3 billion in long-term debt in 1980. Similarly, Ford experienced negative cash flows in 1979 and 1980 totaling about $3.7 billion. As a result, the company's total debt (long- and short-term) increased by almost $2 billion in 1980.

Our cash-flow projections for General Motors and Ford for 1981 and 1982 indicate that the companies will continue to face cash-flow problems at least through 1982. These projections were computed by DOT's Transportation Systems Center using a mathematical matrix, and they used two sets of sales forecast data provided by Chase Manhattan Bank's Automotive Division. Scenario A represents cash-flow projections based on the most likely sales forecast. Scenario B uses a lower, or pessimistic, sales forecast in determining cash-flow projections.

General Motors Corporation

Cash-Flow Projections (Worldwide)

	Scenario A		Scenario B	
	1981	1982	1981	1982
	----------(millions)----------			
Sources:				
Net cash inflow from operations excluding: 1) Amounts received as proceeds from long-term debt or equity transactions 2) Amounts paid on capital assets acquired (principal payment on long-term debt and downpayments)	$6,446	$8,586	$5,712	$7,677
Application:				
Dividends paid	860	1,500	860	1,500
Amount paid on capital assets acquired	8,000	8,300	8,000	8,300
Total application	$8,860	$9,800	$8,860	$9,800
Cash flow (negative)	-$2,414	-$1,214	-$3,148	-$2,123
Cumulative cash flow		-$3,628		-$5,271

Ford Motor Company

Cash-Flow Projection (Worldwide)

	Scenario A		Scenario B	
	1981	1982	1981	1982
	----------(millions)----------			
Sources:				
Net cash inflow from operations excluding: 1) Amounts received as proceeds from long-term debt or equity transactions 2) Amounts paid on capital assets acquired (principal payment on long-term debt and downpayments)	$2,661	$3,944	$2,328	$3,656
Application:				
Dividends paid	140	200	140	200
Amount paid on capital assets acquired	3,750	4,100	3,750	4,100
Total application	$3,890	$4,300	$3,890	$4,300
Cash flow (negative)	-$1,229	-$ 356	-$1,562	-$ 644
Cumulative cash flow		-$1,585		-$2,206

In interpreting these cash-flow projections, the negative figures represent an estimate of the aggregate financial pressures on the companies based on the projected cash flows from operations and planned capital spending requirements. Although the companies may have to borrow funds to support the projected capital expenditures, it should not be assumed that they will automatically incur additional debt to make up the shortfalls indicated by these projections. Rather, they might take actions which avoid increasing their long- and short-term debt indicated by our projections. Moreover, we recognize that our projections are not precise measurements of either companies' actual cash-flow position. Our work was aimed at providing some reasonable framework for measuring the direction of cash flow of the two auto companies during the present transition to producing smaller and more fuel-efficient cars.

In essence, the auto companies face the challenge of seeking to balance (1) the large amount of borrowing needed to produce new fuel-efficient vehicles plus the financial burdens that borrowing adds to the companies' cost structures with (2) the profit potential of the new vehicles.

The auto companies have several alternatives available to reduce the cash-flow problems indicated by our projections. Among these are:

--Deferring projects, thus reducing investment--tooling, machinery, new plants--as well as other project costs--preproduction engineering and launch costs.

--Changing historical "make or buy" decisions to purchase components from outside sources, thus reducing capital spending for plant and equipment.

--Supplying the North American market with vehicles or components already produced by foreign subsidiaries, which would reduce capital spending in domestic plants.

--Reducing fixed costs by staff layoffs and other cost-cutting measures, such as phone bills, office supplies, consultant services, and computer use.

As we have said, the automotive companies have various strategies for altering the cash-flow projection that we computed. For instance, in the fall of 1981, Ford announced that it had reduced its capital investment spending to about $2.5 billion compared with our estimate of $3.7 billion for 1981. Also, Ford's reported loss of $334.5 million through the third quarter of 1981 indicates that the annual rate of income may be lower than our projection of income for the year.

Although the auto companies are under pressure to decrease expenditures to reduce the amount of debt they undertake, reduced investments will delay delivery of the new products needed

to meet the demand for smaller, more fuel-efficient cars. Thus, their borrowing needs will probably be extensive. Long-term debt as a percentage of total capital increased for both General Motors and Ford in 1980.

Long-Term Debt as a Percentage of Total Capital

	1979	1980
	(percent)	
General Motors Corporation	4	10
Ford Motor Company	11	19

Given the cash-flow pressures indicated by our projections for 1981 and 1982, General Motors and Ford will probably have to continue borrowing funds to finance the new front-wheel drive, fuel-efficient cars presently in demand.

The financial positions of these companies might improve in 1983 and 1984. Improvement will depend on improved sales performance, both foreign and domestic. On the other hand, a sales slump of any duration during that period would result in cash positions deteriorating rapidly from the already weakened positions indicated by our 1981 and 1982 cash-flow projections.

The domestic automobile industry's cash-flow problems have also been noted by DOT in its report entitled "The Automobile Industry, 1980." The report concluded that:

> "In financial terms, barring surprisingly positive economic conditions over the next few years, the domestic companies will not very likely be able to sustain in the later part of the decade an investment program approaching the magnitude of the current one. Even under optimistic projections, the domestic companies in 1985 will still be recovering from the current problems and will very likely be in a relatively weak financial position, compared to the last several decades. Each company will still be retiring debt and other financial obligations incurred over the early part of the decade and will still require a number of years of positive cash generation to fully reach historical norms."

STUDIES TO ASSESS FUTURE FUEL ECONOMY

Several studies have been made of potential fuel economy gains beyond 1985. These studies generally agree that technology exists to improve fuel economy on a fleet basis beyond 1985 levels. However, the studies point out that improving the fuel economy during the post-1985 period would require large capital

investments which could expose the auto industry to financial risks. The various studies made post-1985 fuel economy projections that we categorized into two scenarios:

--A moderate improvement (35- to 40-mpg range) by the early to mid-1990's.

--A rapid improvement (over 40 mpg) by the 1990's.

The moderate gain scenario assumes that although the present fleet mix--full-size, intermediate, compact, and subcompact--will continue to shift toward compact and subcompact, the full-size and intermediate cars, although smaller than today's models, will still be in demand. Most of the fuel economy gains will come primarily from extending existing technology involving weight reduction through downsizing and material substitution, smaller turbo-charged gasoline and diesel engines, improved aerodynamics, and electronic fuel systems. (A brief discussion of each of these technologies is contained in app. I.)

The rapid gain scenario calls for a dramatic shift in new-car demand with small, lighter weight vehicles and two-passenger commuter vehicles dominating the new-car fleet. Large cars would be available but in far fewer numbers. In this scenario the same technologies used in the moderate scenario would be employed but at an accelerated pace.

From the standpoint of financial risk, the moderate approach would allow domestic auto companies to return to more normal capital spending levels compared to the large investment levels in the 1980-84 period. The rapid scenario, however, would require a continued high rate of capital spending which the domestic companies may not be able to afford.

The basic differences between the two scenarios deal with the level of technology use, the amount of change in the fleet mix to more fuel-efficient cars, the level of capital investment required (financial risk), and the time (years) required to make the changes.

Moderate improvement scenario

Three studies highlighted under the moderate scenario project that the passenger-car fleet will achieve a fuel economy average in the 35- to 40-mpg range by the early to mid-1990's. Announced manufacturers' product plans by 1985 call for a continuation of a variety of models offered in 4-, 5-, and 6-passenger cars. Assuming manufacturers' projections of around 30 mpg are achieved by 1985, average increases under this scenario will be one-half to 1 mpg annually thereafter. Increases in fuel efficiency will primarily come via improvements in engines and transmissions and in lightweight material substitution. The studies concluded that these improvements can be made with a return to normal capital spending levels, which the auto

companies would need to regain their financial health. The three studies are discussed below.

A CBO study entitled "Fuel Economy Standards for New Passenger Cars After 1985," dated December 1980, indicated that increased use of the current technologies could raise the new-car fuel economy fleet average to the 35- and 40-mpg range by 1995. An increased market shift to small cars could raise the average to 42 mpg by 1995 but is contingent upon the price of gasoline. CBO believes as the price of gasoline nears $2 per gallon, the market shift to smaller cars will help achieve the 42-mpg average. To reach a 40-mpg fleet by 1995, CBO estimated that the industry would need to invest $8 billion annually. Also, CBO estimated that about $7 billion of these investments reflect the industry's ongoing annual investment for normal, or business-as-usual, capital replacement requirements. Thus, it would cost industry about $10 billion to achieve improved fuel mileage through 1995.

DOT's report on "The Long Term Viability of the Chrysler Corporation's Involvement in the Automotive Industry," dated January 1981, concluded that the 1990 car fleet will probably have a fuel economy of 30 to 35 mpg with few sacrifices in performance or utility. The cars will have front-wheel drive and 4-cylinder engines. The variety of models offered of 4-, 5-, and 6-passenger cars will not be much different from that projected by the automakers for 1985. DOT concluded the domestic automakers could attain this improvement while returning to historic capital spending levels and thus give themselves time to recover from the high debt incurred during the 1980-84 period.

Similar projections were described by the Energy Productivity Center of the Mellon Institute in a report entitled "Maintaining Automotive Mobility: Using Fuel Economy and Synthetic Fuels to Compete with OPEC Oil," dated August 1980. The report indicated that by increasing implementation of known technology without altering the product line from the automakers' 1985 plans, fuel economy averages should be 38 mpg in 1990 and about 41 mpg in 1995. The report estimated that domestic manufacturers' capital spending will average $6 billion annually through 1990, taper off for a few years, and then increase in the mid-1990's for the introduction of advanced engines and alternate materials.

Rapid improvement scenario

The rapid improvement scenario calls for fuel economy above 40 mpg in passenger cars by the early 1990's. The studies reviewed concluded that to exceed the 40-mpg level is technologically feasible, as a few of today's models are rated over 40 mpg. However, a fleet of vehicles averaging over 40 mpg would require a significant increase in the number of 2- and 4- passenger cars compared with the mix projected for the moderate improvement scenario. An improvement of 2 mpg or higher

annually would require sacrifices in vehicle acceleration and more use of 2- and 3-cylinder engines, electric cars, and an increased use of lighter weight materials.

The CBO report entitled "Fuel Economy Standards for New Passenger Cars After 1985" stated that its moderate scenario--attaining a 40-mpg fleet average by 1995--can be accelerated 5 years to 1990. The accelerated pace, however, would require a continued high rate of capital investment--about $12.5 billion annually as opposed to $8 billion under the moderate scenario. The report recognized that a continued high capital investment level could expose the industry to significant financial pressure and risk. Although questioning whether the companies can sustain these levels of capital spending, the report stated that it may be necessary if they are to remain competitive.

An alternate scenario developed by DOT in its report entitled "The Long Term Viability of the Chrysler Corporation's Involvement in the Automotive Industry," dated January 1981, projected that fuel economy could average between 40 and 50 mpg in the early 1990's. The report noted that this level would, however, unveil a fleet significantly different than today's. For example, such a car fleet would average 1,825 pounds, have front-wheel drive with 75 percent powered by conventional spark ignition and 25 percent by diesel engines of four or less cylinders, and be capable of carrying four passengers. Projected capital spending to attain such a fleet would be about $100 billion. Although a 40- to 50-mpg fleet is technologically feasible, DOT concluded that the massive investment required may be beyond the domestic companies' financial ability.

The Director of the Emission Control Technology Division, EPA, testified before the Senate Committee on Energy and Natural Resources in April 1980, on his own behalf, on the potential for improved automobile fuel economy between 1985-95. He indicated that by varying the technology and mix of vehicles, the fleet average fuel economy could range from 75 mpg all the way to 122 mpg, with 84 mpg as the optimum from a cost and acceptance standpoint. These vehicles would be radically different from today's. For example, engines would be available in two, three, and four cylinders but with greatly reduced horsepower, in the range of 18 to 45 horsepower. Also, he stated that capital cost to build such a fleet of vehicles could exceed $150 billion. Further, he stated that the availability of capital to the domestic industry would be a problem and suggested that the Federal Government must provide some means of financial assistance.

Fuel consumption estimates
and potential for fuel savings

In the short run (1981-90) the United States will probably experience a decline in automobile fuel consumption. In the long run the projections become more uncertain, but that is the

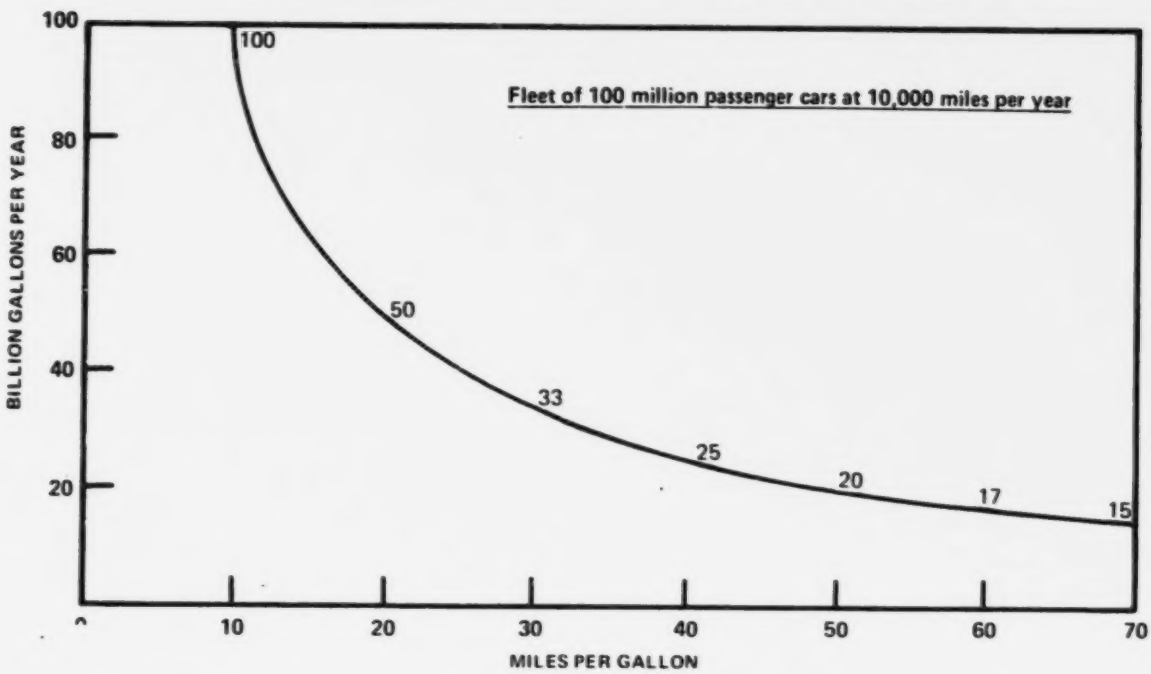
period during which alternative fuels are expected to become available for mass consumption.

Each increase in the automobile fuel economy level will result in additional fuel savings, assuming constant miles driven. However, due to the principle of diminishing returns, each incremental increase in mpg will yield successively smaller fuel savings than previous mpg increases. For example, if you use 100 gallons of gasoline to travel a given distance, then doubling your mpg results in a 50-gallon savings. However, a second doubling of mpg yields a 25-gallon savings, then 12.5, 6.25, etc. The same concept holds true for the new-car fleet or the total car fleet.

As shown in figure 6, we estimated that a fleet of 100 million cars averaging 13.5 mpg (the approximate fleet fuel-efficiency average in 1975) and each car driving an average of 10,000 miles per year, would use about 74 billion gallons of gasoline per year. Assuming the same number of miles driven, we estimated that a fleet of cars averaging 30 mpg would consume about 33 billion gallons a year--for a savings of 41 billion gallons. Again, using the same assumptions, we estimated that a fleet average of 60 mpg would drop from 33 to 16.7 billion gallons per year. Thus, the first round improvement would save 41 billion gallons per year while the second round would save 16 billion gallons.

FIGURE 6

DIMINISHING RETURNS OF HIGHER FUEL EFFICIENCY



Estimates of future fuel consumption

Our analysis indicated that for the next 8 to 10 years the U.S. automobile fuel consumption will probably decline even if new cars are no more fuel-efficient than the 30-mpg fleets now being developed. In the long run, if total yearly mileage driven grows at a 3.5-percent annual rate experienced during the period 1959-79, fuel consumption in the year 2000 may be double the amount estimated in the no-mileage growth scenario, as shown in the following table.

Estimated Automobile Fuel Consumption in Year 2000

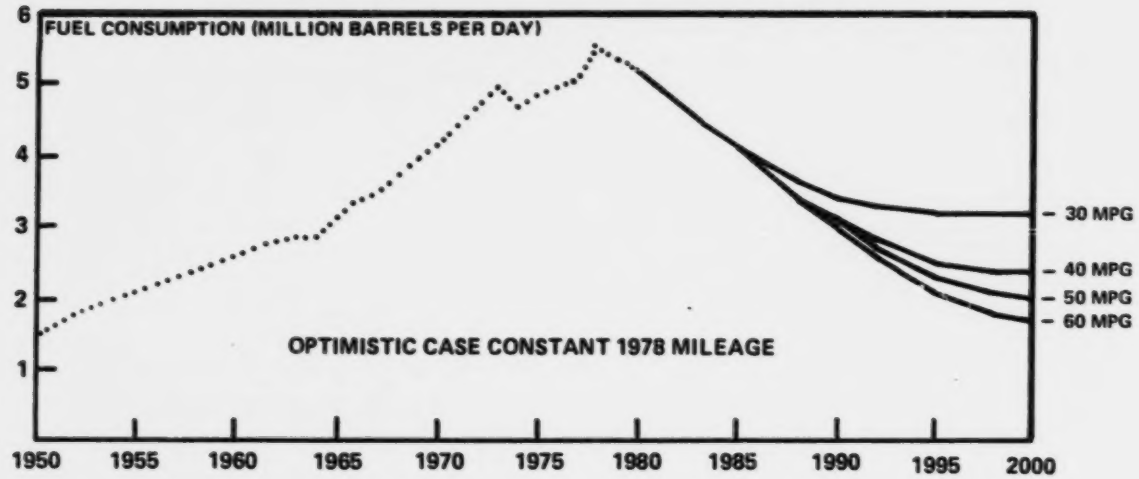
Our assumptions	mpg			
	30	40	50	60
	(million barrels per day)			
3.5-percent annual growth in miles (pessimistic)	6.8	5.1	4.3	3.6
No growth in miles driven (optimistic)	3.2	2.4	2.0	1.7
Growth in miles per regression model (base case)	3.1	2.4	2.1	1.8

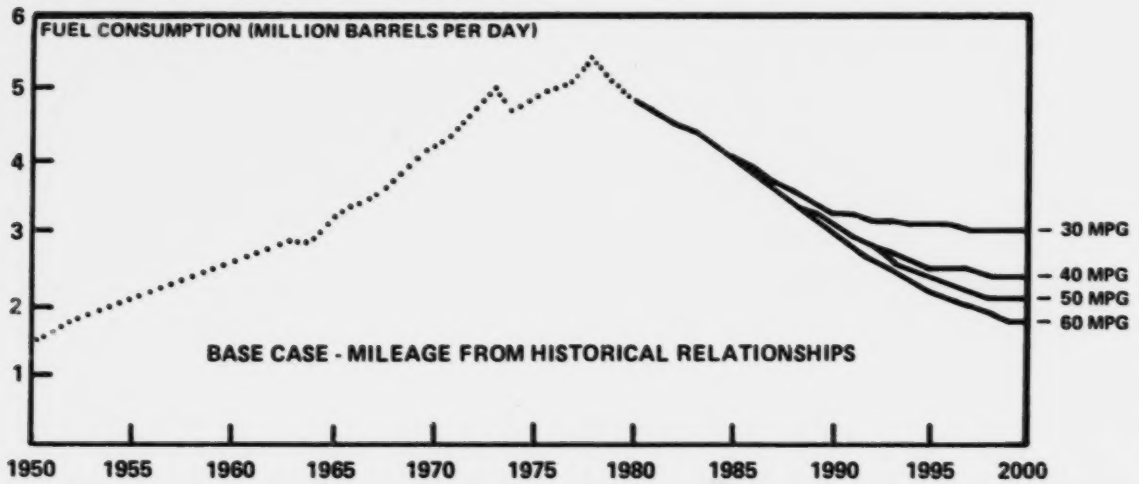
Fuel consumption was estimated for the above three assumptions based on annual miles driven. The first scenario is considered pessimistic and used 3.5 percent annual growth in miles driven--the approximate rate of growth before the supply disruptions of 1979-80. The no-growth scenario uses yearly mileage fixed at the 1978 level and may be considered as an optimistic estimate. The constant mileage assumption is a proxy for a standoff between the forces that would tend to increase miles driven (i.e., rising incomes, population, gross national product, etc.) with those factors that decrease miles driven (i.e., rising fuel prices, diminishing supplies, etc.). For the third scenario, or base case, the number of miles driven was estimated from a regression analysis--a statistical technique for measuring the relationship among various factors. The factors considered to influence miles driven were number of households, per capita disposable income, gasoline prices, automobile fuel efficiency, and the disruption of gasoline supplies. (For further details on the methodology employed, see p. 7.)

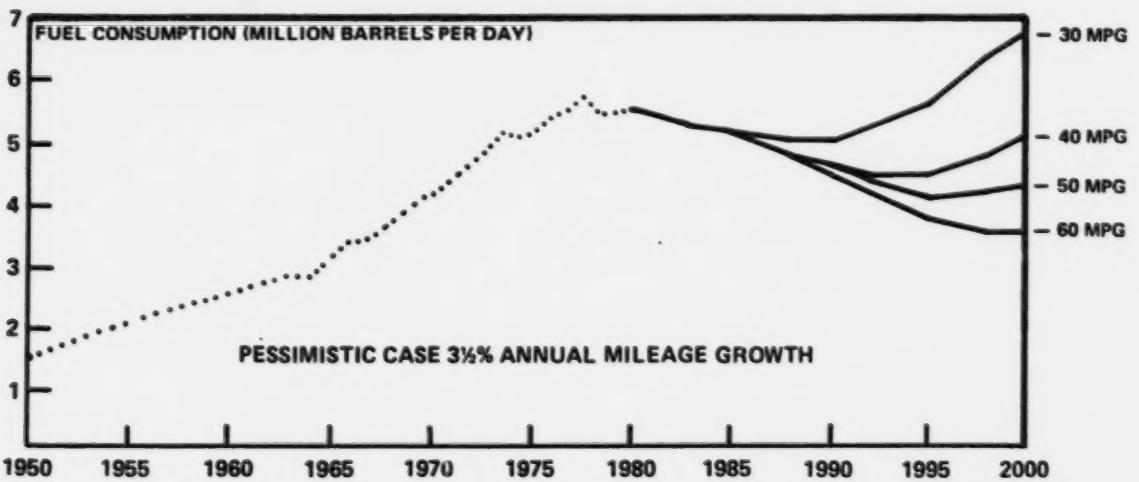
Figure 7 contains three graphs, one for each of our three assumptions concerning miles driven. On each graph are lines depicting consumption if new-car fleets were to achieve 30, 40, 50, or 60 mpg. Each graph illustrates the principle of diminishing returns. For example, the amount of fuel saved as the fuel efficiency goes from 30 to 40 mpg is greater than that saved as efficiency increases from 40 to 50 mpg.

FIGURE 7

PROJECTED PASSENGER CAR FUEL CONSUMPTION







In the short run (1981-90), the Nation will probably experience a continuing decline in automobile fuel consumption. This decline in fuel consumption will take place barring any major shift in miles driven, the price of gasoline, or the state of the economy. Major factors contributing to the decline in fuel consumption are (1) manufacturers are locked into engineering, design, and production methods for producing fuel-efficient automobiles and (2) in the short run most older cars in the fleet are being replaced by significantly more fuel-efficient new cars. Thus, even if newer car fuel efficiency were to be frozen at today's levels, the fleet average consumption will most likely be reduced.

In the longer run, and the further out into the future, the more uncertain these projections become. The base case and optimistic projections indicate a leveling out of consumption in the 1990-2000 period. In contrast, the pessimistic case assumption indicates that by 1995 the impacts of continual increases in driving overpower the cumulative gains in mpg for all but the highest level of fuel economy. This period of relatively high uncertainty is also the period during which alternative fuels are scheduled to become available for mass consumption according to an OTA study entitled "Changes in the Future Use in Characteristics of the Automobile Transportation System."

CONGRESSIONAL CONCERN WITH FUTURE FUEL STANDARDS

The Congress continued to show concern for future automobile fuel economy improvements after it passed the Energy Policy and Conservation Act of 1975. During the 96th Congress, the Senate Committees on Energy and Natural Resources and Commerce, Science, and Transportation reviewed the possibility of setting higher standards beyond 1985. An amendment to a Senate bill was made that would have set an average fuel economy standard of 40 mpg for new cars sold in 1995. Standards for interim years 1985-95 would have been established by the Secretary of Transportation. No action was taken on the bill.

In June 1981 the Subcommittee on Energy Conservation and Power of the House Committee on Energy and Commerce held hearings to examine the policy for potential fuel savings from the automobile sector, particularly in light of the auto industry's financial problems. Although the subcommittee has not taken further action, the hearings indicate that congressional interest in fuel economy continues.

CONCLUSIONS

To produce more fuel-efficient cars, the automobile industry plans to spend more than $70 billion through 1984. This capital spending rate will pay for the extensive retooling of facilities to build smaller cars with technological innovations.

Although domestic manufacturers are committed to these huge investments, revenues to finance them have shrunk. Rising new-car prices and interest rates and increased imports have contributed to the auto industry's $4 billion losses in 1980. Our cash-flow projections indicate that General Motors Corporation may have negative cash flows of between $3.6 and $5.4 billion and Ford Motor Company may have negative cash flows of between $1.6 and $2.2 billion in 1981 and 1982. We recognize that the automotive companies have various strategies that could alter our cash-flow projections.

Recent studies by DOT and CBO indicated that the current round of investments will leave all domestic automakers financially weakened compared to their positions over the past several decades. Also, the studies indicated that continuing a high rate of capital investment after 1985 may place significant financial pressure on the automakers.

TECHNOLOGICAL CHANGES FOR FUEL ECONOMY

Several common technological items have improved or could improve the potential for fuel economy. Brief descriptions of these technologies follow:

1. Weight reduction

Weight reduction is separated into two programs--downsizing and material substitution.

Downsizing. The goal of the downsizing program is to repackage the motor vehicles in a manner which reduces car weight but still retains roominess and performance. Downsizing usually reduces the wheel base, cuts vehicle length by reducing front and rear overhang, and in some cases increases the vehicle's height. This gives cars a more rectangular shape but keeps the same interior space.

Material substitution. Weight reduction is also achieved by redesigning vehicle components and using lighter weight materials. Components are redesigned to provide the same function in the vehicle while using less material to save weight. Many component design changes are incorporated with downsizing actions. Substitution of lighter weight materials--such as aluminum; plastic; and high-strength, low-alloy steels--are replacing high-carbon steel in such items as doors, hoods, and bumpers to reduce weight.

2. Aerodynamics

Aerodynamic design can improve fuel economy by reducing the amount of drag from headwind and crosswind. Aerodynamic design is accomplished when a vehicle is redesigned in conjunction with downsizing actions.

3. Rolling resistance

Rolling resistance is the frictional loss associated with motion of wheels. Rolling resistance improvements are being pursued in three areas:

--Improved tire design to reduce rolling friction.

--Increased tire pressure to reduce rolling resistance.

--Reduced disc-brake drag.

Improvement in tire redesign and pressure is being pursued by the tire companies.

4. Lubricants

Lubrication improvements can be made in the operation of transmissions, engines, differentials, and wheel bearings.

Synthetic lubricants offer benefits over conventional engine oils with their ability to reduce engine friction at extreme temperatures.

5. Transmissions and drivetrain

Fuel economy improvements are being made by increasing the number of manual transmissions sold, especially four- and five-speeds, with overdrive. Also, improvements are being made in three- and four-speed automatic transmissions with torque converter lockup features, which improve engine-transmission matching. The lockup torque converter mechanically links the engine and drivetrain during cruise conditions, thereby eliminating slippage which results in a loss in fuel economy. The fuel economy benefits of the four-speed automatic transmission stem from a change in the gear ratio which facilitates lower engine speeds and reduced pumping losses.

The transverse front-wheel-drive design configuration involves mounting an engine parallel to and above the front axle and transmits power directly from the engine to the front wheels. This configuration eliminates some weight by reducing the size of the engine compartment and by eliminating the rear drive shaft and differential which allows the interior volume to be used more efficiently while downsizing the exterior. But, front-wheel drive by itself improves fuel economy little, if at all, over a rear-wheel-drive vehicle of the same weight. Front-wheel drive allows downsizing and smaller fuel-efficient engines, and this is what improves fuel economy.

6. Turbocharging

Turbocharging an engine is intended to increase performance. It does not improve the fuel economy of a gasoline engine; however, some fuel savings are realized with a turbocharged diesel engine. A turbocharger is an air compressor used to force a greater amount of air-fuel mixture into the cylinder to increase the power of the engine. Fuel economy benefits of a turbocharger can be realized when a smaller engine is substituted in a vehicle, or the drive ratio is changed.

7. Electronic controls

An electronic control system is used to control three basic operating variables: air-fuel ratio, ignition timing, and exhaust gas recirculation. The controls are basically a sensor and actuator mechanism that optimizes the balance between fuel efficiency and emissions control.

8. Diesel engines

The diesel engine is an internal-combustion engine whereby fuel is ignited by the heat of compressed air in the cylinder as opposed to an electrical spark in the conventional spark-ignition engine. No spark plugs or carburetor are necessary. With the higher compression ratios and reduction in pumping losses, diesel engines use fuel more efficiently than the conventional spark engine. The future of diesel engines is clouded as there is doubt whether the current emission standards can be met or whether these standards will be modified.

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